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Taxonomic revision on the *Gobio* group in the Yellow River drainage, with discussion on the validity of the genus *Acanthogobio* (Cypriniformes, Gobionidae)

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Abstract

The Yellow River drainage is a biodiversity hotspot for the *Gobio* group, but no one has yet reviewed these species systematically. This study examined the type specimens of the species in the *Gobio* group and numerous newly captured specimens in the Yellow River drainage for an overall morphological comparison. A phylogenetic tree of those species based on mitochondrial cytochrome-*b* sequences was also constructed. Our results indicate the presence of four species, i.e., *Gobio guentheri* (this was described as *Acanthogobio guentheri*), *G. rivuloides*, *G. coriparoides*, and *G. huanghensis*. Morphological and molecular phylogenetic analyses indicated that *G. tchangi* is a junior synonym of *G. huanghensis*, while *G. meridionalis* is a junior synonym of *G. rivuloides*. Additionally, the phylogenetic analysis showed that the genus *Acanthogobio* is nested within *Gobio*. In order to maintain the monophyly of *Gobio*, this study suggests that the genus *Acanthogobio* should be a junior synonym of *Gobio*, and the type species *A. guentheri* should be treated as *Gobio guentheri*. Furthermore, the type specimens of *Romanogobio johntreadwelli* and *R. amplexilabris* were checked, and this study confirmed that these two species are junior synonyms of *G. rivuloides*. Therefore, the genus *Romanogobio* is not distributed in the Yellow River drainage. The *Gobio* species are primarily distributed in the upper and middle reaches of the Yellow River drainage, from Qushian Township, Qinghai Province, to Sanmenxia City, Henan Province, at an average elevation above 300 meters. A diagnostic key for four valid *Gobio* species in the Yellow River drainage is provided.

Key Words

East Asia, freshwater fish, morphology, phylogenetic analysis, taxonomy

Introduction

The Yellow River is the second longest river in East Asia; it is located between 35°N and 43°N latitude and 112°E and 120°E longitude. Originating from the Bayan Har Mountains on the Qinghai-Tibet Plateau, the Yellow River flows through nine provinces over 5,464 kilometers and eventually drains into the Bohai Sea, with a drainage area of 752,546 square kilometers (Song et al. 2022). Based on the characters of the riverscape and environment, this long river was divided into three sections: the upper reaches were defined from the origin to Hekou Township, Togtoh County, Inner Mongolia Autonomous Region; the middle reaches, from Togtoh County to Taohuayu, Zhengzhou City, Henan Province; and the lower reaches were defined as the section downstream of Taohuayu (Yellow River Conservancy Commission 2013). There are 147 native freshwater fishes recorded in this vast river drainage (Zhao et al. 2020).

The Yellow River drainage is a biodiversity hotspot for the *Gobio* group in East Asia. This monophyletic group

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within the family Gobionidae includes the genera *Gobio*, *Acanthogobio*, *Romanogobio*, and *Mesogobio* (Yang et al. 2006), and three genera (i.e., *Gobio*, *Acanthogobio*, and *Romanogobio*) occur in the Yellow River drainage. The genus *Gobio* is a group of small-sized freshwater fish widely distributed across Eurasia (Chen 1998; Kottelat and Freyhof 2007). They are characterized by having one pair of barbels, mouth inferior, gill rakes rudimentary, thoracic region flattened and naked, possessing seven branched dorsal-fin rays and six branched anal-fin rays (Luo et al. 1977; Chen 1998). A total of 11 species inhabit East Asia (Wu et al. 2012; Li 2015), and five of them have been recorded in the Yellow River drainage (Li 2015). *Romanogobio* is distinguished by epithelial crests on scales on the dorsal half of the body, a depth of caudal peduncle 2.6–4.2 times in caudal peduncle length, and an anus closer to the pelvic-fin base than to the anal-fin origin (Naseka 1996; Kottelat and Freyhof 2007). This genus is mainly distributed in Europe, with only two species distributed in the Yellow River drainage (Naseka 1996; Kottelat and Freyhof 2007; Wu et al. 2012). *Acanthogobio* is a monotypic genus, and *A. guentheri* is the only species (Herzenstein 1892). It is restricted to the upper reaches of the Yellow River drainage and is characterized by several distinct features: barbel reaching between posterior preopercle margin and posterior opercular margin; ventral scaleless region extends beyond pelvic-fin; the absence of scales on the pre-dorsal region; anus positioned at the posterior one-third of the distance from pelvic-fin base end to anal-fin origin; and the second unbranched ray of the dorsal fin forms a stiff spine (Chen 1998).

Eight species within the *Gobio* group have been recorded from the Yellow River in the past centuries. They are *Acanthogobio guentheri* from the upper reaches; *Gobio rivuloides*, *G. huanghensis*, *G. tchangi*, *G. coriparoides*, *Romanogobio johntreadwelli*, *Romanogobio amplexilabris*, and *G. meridionalis* from the upper and middle reaches. Although numerous taxonomists have recorded those species from the *Gobio* group in the Yellow River drainage (Herzenstein 1892; Nichols 1925; Bănărescu and Nalbant 1973; Luo et al. 1977; Chen et al. 1987; Li 2015), no one has yet reviewed these species. Therefore, it is necessary to conduct an overall review of the *Gobio* group in the Yellow River drainage and provide an accurate diagnostic key to them. In this study, based on the specimens collected from the Yellow River drainage and the adjacent river system, and also the type materials of each species, we are able to compare the differences among these species and determine their validity.

Material and methods

Specimen collection, examination, and preservation

Most of the specimens were collected between 2022 and 2024 from the main stream and tributaries of the Yellow River drainage, including the Fenhe, Luohe, and Qinhe Rivers, and some small tributaries. Fish were collected using fish traps and hand nets. After collection, the specimens were fixed in 10% formaldehyde and stored in 70% ethanol, or directly fixed in 95% ethanol. Meanwhile, some *Gobio rivuloides* specimens collected from the Haihe River drainage were also used for comparison since the type locality of this species is Niang-tze Kwan (=Niangziguan Township, Pingding County, Yangquan City, Shanxi Province), which belongs to the Haihe River drainage.

The holotype of the *Gobio tchangi* is preserved at the Institute of Zoology, Chinese Academy of Sciences, Beijing, China (ASIZB, abbreviation follows Sabaj, 2020; 2023). The syntypes of *G. huanghensis* and paratypes of *G. meridionalis* are at the Institute of Hydrobiology, Chinese Academy of Sciences, Hubei, China (IHB), and holotypes of *G. rivuloides*, *G. coriparoides*, *Romanogobio johntreadwelli*, and *R. amplexilabris* are at the American Museum of Natural History, New York, the United States (AMNH).

Morphological study

Measurements were taken on the left side of the specimens using a digital caliper, which rounded to 0.01 mm; all measurements were made point to point, never by projection. Counts were also made on the left side of specimens. If the scales or fin rays were damaged from the left side, counts were made on the right side. Methods for counts and measurements followed Zhao and Sun (2021). The lateral line scales include the scales on the caudal-fin base. The last two rays in dorsal and anal fins based on a single pterygiophore were counted as one ray. Only adult specimens (larger than 60 mm standard length) were measured; juveniles and smaller, bent, or damaged specimens were not included in the measurements (Kottelat and Persat 2005). To determine the position of the anus, we define the distance from the posterior margin of the pelvic-fin base to the anterior edge of the anus as the pelvic fin-anus distance, and the distance from the anterior edge of the anus to the anal-fin as the anus-anal fin distance.

In order to get a general perception on external morphologic differences, nineteen measurable traits, $\log_{10}$-standardized to eliminate the allometries, were input into Past v4.17 (Hammer and Harper 2001) for principal component analysis (PCA).

Molecular phylogenetic analyses

Molecular studies were based on the mitochondrial Cytochrome-*b* (Cyt *b*) sequences. DNA was extracted from the pelvic fin on the right side of the fish. The Cyt *b* gene was amplified using primers L14724 (5'-GACTTGAAAAACCACCGTTG-3') and H15915 (5'-CTCCGATCTCCGGATTACAAGAC-3') following He and Chen (2009). Sequencing reactions were performed according to the operating instructions of BigDye Terminator v3.1 (BDT),

with 1 µL of primer (3.2 pmol/µL), 1 µL of template DNA, 2 µL of BigDye® Terminator v3.1, and 6 µL of double distilled water (dd H2O) for a total reaction volume of 10 µL. The thermo-cycling conditions were initial denaturation for 2 min at 96 °C, denaturation for 10 s at 96 °C, annealing for 10 s at 50 °C, and extension for 1 min at 60 °C. After 30 cycles, a final extension was performed at 60 °C for 3 min, and the polymerase chain reaction (PCR) products were preserved at 4 °C. Sequencing was carried out by Beijing TsingKe Biotech Co., Ltd. (China).

The sequencing results were assembled using SeqMan, and other sequences were acquired from the NCBI database. The voucher ID of each individual and GenBank accession number are given in Table 1. Twenty-six Cyt *b* sequences of *Gobio* species were included in the molecular phylogenetic analyses. *Hemibarbus labeo* was used as an outgroup. Nucleotide sequence alignment was conducted using MEGA 11 (Kumar et al. 2018) with ClustalW. ModelFinder (Kalyaanamoorthy et al. 2017) was used to select the best-fit model using Bayesian information criterion (BIC). The Bayesian inference (BI) phylogenies were inferred using MrBayes v3.2.6 (Ronquist et al. 2012) under the GTR model (two parallel runs, 2,000,000 generations), with the initial 25% of sampled data discarded as burn-in. The final phylogenetic trees were modified on the TVBOT: Tree Visualization By One Table (https://www.chiplot.online/tvbot.html, Xie et al. 2023). Each sequence was labeled with its own taxonomic nomenclature, and the evolutionary divergence of sequence pairs between and within groups (i.e., species) was estimated using the Kimura 2-parameter model (Kimura 1980).

Results

Based on morphological comparisons and molecular phylogenetic analyses, we conclude that there are four valid species distributed in the Yellow River drainage: *Gobio huanghensis* Lo, Yao & Chen, 1977; *G. rivuloides* Nichols, 1925; *G. coriparoides* Nichols, 1925; and *G. guentheri* Herzenstein, 1892. A diagnostic key to these species is given herein.

Table 1. Voucher codes, sampling localities and accession numbers of *Gobio* group species and outgroup for molecular phylogenetic analyses.

Voucher Code	Species	Locality	Drainage	Accession no.	Source
–	*Gobio huanghensis*	Hainan Tibetan Autonomous Prefecture, Qinghai Prov. China	Yellow River	FJ904648	Qi et al. from NCBI (Unpublished)
ASIZB 242021	*G. huanghensis*	Xing County, Shanxi Prov. China	Yellow River	–	This study
ASIZB 242022	*G. huanghensis*	Xing County, Shanxi Prov. China	Yellow River	–	This study
ASIZB 242025	*G. huanghensis*	Baode County, Shanxi Prov. China	Yellow River	–	This study
ASIZB 242026	*G. huanghensis*	Liulin County, Shanxi Prov. China	Yellow River	–	This study
ASIZB 242030	*G. huanghensis*	Hangjin Banner, Inner Mongolia Aut. Reg. China	Yellow River	–	This study
ASIZB 242040	*G. huanghensis*	Lin County, Shanxi Prov. China	Yellow River	–	This study
IHB 0411036	*G. coriparoides*	–	–	JN003326	Tang et al. 2011
–	*G. coriparoides*	Luonan County, Shaanxi Prov. China	Luohe R., Yellow River Drainage	EU934492	Liu et al. 2010
ASIZB 241456	*G. coriparoides*	Jingle County, Shanxi Prov. China	Fenhe R., Yellow River Drainage	–	This study
ASIZB 242015	*G. coriparoides*	Jingle County, Shanxi Prov. China	Fenhe R., Yellow River Drainage	–	This study
ASIZB 242033	*G. coriparoides*	Lan County, Shanxi Prov. China	Fenhe R., Yellow River Drainage	–	This study
ASIZB 242038	*G. guentheri*	Jishishan Bonan, Dongxiang and Salar Autonomous County, Gansu Prov. China	Yinchuan R., Yellow River Drainage	–	This study
ASIZB 242039	*G. guentheri*	Jishishan Bonan, Dongxiang and Salar Autonomous County, Gansu Prov. China	Yinchuan R., Yellow River Drainage	–	This study
ASIZB 242061	*G. guentheri*	Liulin County, Shanxi Prov. China	Yellow R.	–	This study
–	*G. rivuloides*	Yushe County, Shanxi Prov. China	Zhuozhanghe R., Haihe River drainage	OP354083	Ni et al. 2023
–	*G. rivuloides*	Yushe County, Shanxi Prov. China	Zhuozhanghe R., Haihe River drainage	OP354084	Ni et al. 2023
ASIZB 219283	*G. rivuloides*	Huguan County, Shanxi Prov. China	Xihe R., Haihe River Drainage	–	This study
ASIZB 239687	*G. rivuloides*	Shangyi County, Hebei Prov. China	Yanghe R., Haihe River Drainage	–	This study
ASIZB 241457	*G. rivuloides*	Pingshan County, Hebei Prov. China	Hutuohe R., Haihe River Drainage	–	This study
ASIZB 242027	*G. rivuloides*	Luonan County, Shaanxi Prov. China	Luohe R., Yellow River Drainage	–	This study
ASIZB 242028	*G. rivuloides*	Luonan County, Shaanxi Prov. China	Luohe R., Yellow River Drainage	–	This study
ASIZB 241459	*G. meridionalis*	Xing County, Shanxi Prov. China	Yellow R.	–	This study
ASIZB 242016	*G. meridionalis*	Bohaiwan County, Inner Mongolia Aut. Reg. China	Yellow R.	–	This study
ASIZB 242018	*G. meridionalis*	Bohaiwan County, Inner Mongolia Aut. Reg. China	Yellow R.	–	This study
ASIZB 242062	*G. meridionalis*	Daning County, Shanxi Prov. China	Yellow R.	–	This study
UAIC 14403.01	*Romanogobio ciscaucasicus*			JN003325	Tang et al. 2011
HDBI1292–773	*R. benacensis*	Kamenita Vrata, Croatia	Mirna R.	MG791924	Jelić et al. 2018
HDBI1323–771	*R. benacensis*	Kamenita Vrata, Croatia	Mirna R.	MG791926	Jelić et al. 2018
Outgroup					
–	*Hemibarbus labeo*	–	–	DQ267432	Lim et al. from NCBI (Unpublished)

Key to the species of genus *Gobio* in the Yellow River drainage

1 Anus centrally located between pelvic-fin base and anal-fin origin or closer to pelvic-fin base 2
– Anus positioned at posterior one-third of distance from pelvic-fin base end to anal-fin origin 3
2 Barbel reaching beyond posterior margin of preopercle, length 41.3%–58.2% of HL; scales above lateral line 6.5; scales below lateral line 4; circumpeduncular scales 16 ..... *Gobio huanghensis*
– Barbel reaching between vertical of posterior edge of orbit and posterior margin of preopercle, length 31.1–42.1% of HL; scales above lateral line 5.5; scales below lateral line 3; circumpeduncular scales 12–14 ..... *Gobio rivuloides*
3 Barbel reaching between vertical of posterior edge of orbit and posterior margin of preopercle margin, length 30.4%–41.2% of HL; the second unbranched dorsal-fin ray soft, thin; scales on pre-dorsal region, ventral scaleless region extends to middle of pectoral-fin base end to pelvic-fin base or just extends to pectoral-fin base end ..... *Gobio coriparoides*
– Barbel reaching between posterior margin of preopercle and posterior margin of opercular, length 53.3%–89.4% of HL; second unbranched dorsal-fin ray stiff, robust; no scales on pre-dorsal region, ventral scaleless region extends to posterior pelvic fin ..... *Gobio guentheri*

Gobio huanghensis Lo, Yao & Chen, 1977

Figs 1–3, Table 2

Gobio huanghensis Lo, Yao & Chen, 1977: 496.

Gobio rivuloides: Institute of Zoology, Chinese Academy of Sciences (1959, not Nichols, 1925): 43.

Gobio tchangi: Li (2015): 178.

Material examined. • IHB 56–IX–004 (Syntype), 1 specimen, 121.9 mm SL, Lanzhou City, Gansu Province, China. ASIZB 56773–56778, 6 specimens, 115.6–157.6 mm SL; near Lanzhou City, Gansu Province, from the main stream of the Yellow River; collected by Sizhong Li; 1958. • ASIZB 232934, 1 specimen, 80.4 mm SL; Liulin County, Lvliang City, Shanxi Province, from the main stream of the Yellow River (37.3891°N, 110.6281°E, ca 630 m a.s.l.); collected by Xin Wang; 31 July 2022. • ASIZB 241489–241490, 241497, 3 specimens, 64.7–107.4 mm SL; Xing County, Lvliang City, Shanxi Province, from the main stream of the Yellow River (38.5196°N, 110.9076°E, ca 770 m a.s.l.); collected by Yutian Fang, 20 October 2023. • ASIZB 242021–242024, 4 specimens, 72.2–128.9 mm SL; Xing County, Lvliang City, Shanxi Province, from the main stream of the Yellow River (38.5193°N, 110.9072°E, ca 780 m a.s.l.); collected by Yutian Fang, 22 May 2024. • 1 ASIZB 242025, specimen, 99.5 mm SL; Baode County, Xinzhou City, Shanxi Province, from the main stream of the Yellow River (38.7821°N, 110.9691°E, ca 780 m a.s.l.); collected by Zhixian Sun, 21 May 2024. • ASIZB 242026, 1 specimen, 106.3 mm SL; Liulin County, Lvliang City, Shanxi Province, from the main stream of the Yellow River (37.3947°N, 110.6316°E, ca 630 m a.s.l.); collected by Yutian Fang, 26 May 2024. • ASIZB 242019–242020, 2 specimens, 118.6–124.6 mm SL; Baode County, Xinzhou City, Shanxi Province, from the main stream of the Yellow River (39.0212°N, 110.0596°E, ca 810 m a.s.l.); collected by Zhixian Sun, 6 July 2024. • ASIZB 242029, 1 specimen, 94.9 mm SL; Daning County, Linfen City, Shanxi Province, from the main stream of the Yellow River (36.4587°N, 110.4876°E, ca 600 m a.s.l.); collected by Zhixian Sun, 8 July 2024. • ASIZB 242030–242032, 3 specimens, 66.8–80.3 mm SL; Hangjin Banner, Ordos City, Inner Mongolia Autonomous Region, from the main stream of the Yellow River (40.6085°N, 107.2969°E, ca 1040 m a.s.l.); collected by Junyuan Hao, 28 June 2024. • ASIZB 242040, 1 specimen, 88.6 mm SL; Lin County, Lvliang City, Shanxi Province, from the main stream of the Yellow River (37.6423°N, 110.7796°E, ca 670 m a.s.l.); collected by Zhixian Sun, 8 July 2024.

Vouchers for molecular study. • ASIZB 242021–242022, 2 specimens, Xing County, Lvliang City, Shanxi Province, from the main stream of the Yellow River (38.5193°N, 110.9072°E, ca 780 m a.s.l.); collected by Yutian Fang, 22 May 2024. • ASIZB 242025, 1 specimen, Baode County, Xinzhou City, Shanxi Province, from the main stream of the Yellow River (38.7821°N, 110.9691°E, ca 780 m a.s.l.); collected by Zhixian Sun, 21 May 2024. • ASIZB 242026, 1 specimen, Liulin County, Lvliang City, Shanxi Province, from the main stream of the Yellow River (37.3947°N, 110.6316°E, ca 630 m a.s.l.); collected by Yutian Fang, 26 May 2024. • ASIZB 242030, 1 specimen, Hangjin Banner, Ordos City, Inner Mongolia Autonomous Region, from the main stream of the Yellow River (40.6085°N, 107.2969°E, ca 1040 m a.s.l.); collected by Junyuan Hao, 28 June 2024.

Diagnosis. This species can be distinguished from other *Gobio* species in the Yellow River drainage by following characteristics: barbel reaching beyond posterior preopercle margin (vs. reaching between vertical of posterior orbit and posterior preopercle margin in *G. rivuloides* and *G. coriparoides*); lateral-line scales 41–44 (mode 43, mean 42) (vs. mean 40 in *G. coriparoides*); circumpeduncular scales 14–16 (mode 16, mean 16) (vs. mean 12 in *G. rivuloides*, 18 in *G. coriparoides* and 20 in *G. guentheri*); longitudinal epithelial crests present on pre-dorsal scales (vs. absent in G. coriparoides and G. guentheri); anus centrally located between pelvic-fin base and anal-fin origin (vs. positioned at posterior one-third of distance from pelvic-fin base end to anal fin origin in *G. coriparoides* and *G. guentheri*).

Redescription. Body elongated, dorsal body profile rising from nostrils to dorsal-fin origin, dropping along dorsal-fin base, then gradually sloping to caudal-fin base.

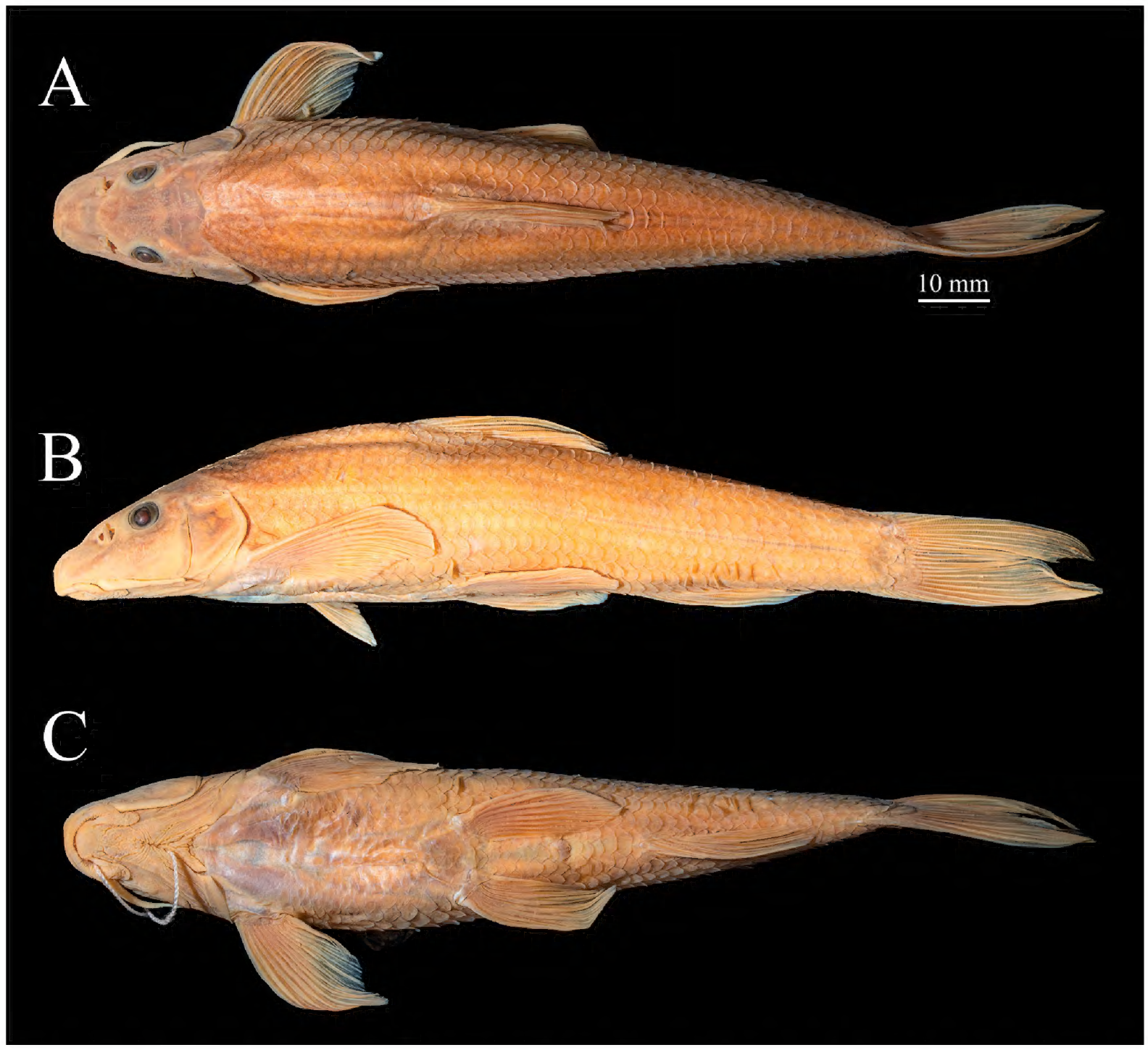

Figure 1. *Gobio huanghensis*, syntype, IHB 56–IX–004, 121.9 mm SL. **A.** Dorsal view; **B** Lateral view; **C** Ventral view; photographed by Yiyang Xu.

Maximum body depth at dorsal-fin origin. Head elongated, length larger than body depth; snout pointed and elongated, with moderate concavity on top of snout before nostrils. Mouth horseshoe-shaped and inferior, with one pair of maxillary barbels root at extremity of upper lip, barbel elongated, extending over posterior preopercle margin. Upper lip thin, lower lip fused with throat, lateral lobes of lower lip well developed, lips connected at mouth corner, tiny papillae on lips, lateral lobes, and chin (Fig. 3A). Eyes positioned on dorsal half of head; interorbital region flattened; width slightly larger than eye diameter. Thoracic region flattened, abdomen rounded, caudal peduncle robust, compressed laterally. Anus centrally located between pelvic-fin base and anal-fin origin.

Body covered with moderately large cycloid scales. Lateral line complete, almost straight in lateral center. Lateral line scales 41 (1 specimen), 42 (7), 43 (11), 44 (3); scales above lateral line 6 (2), 6.5 (19), 7.5 (1); scales below lateral line 3 (1), 4 (21); circumpeduncular scales 14 (2), 16 (20). Longitudinal epithelial crests present on pre-dorsal region scales (Fig. 3B); ventral scaleless region only before pectoral-fin base end.

Dorsal fin with three unbranched and seven (22 specimens) branched rays; distal margin concave, origin closer to snout than caudal-fin base. Pectoral fin with one unbranched and 13 (3), 14 (19) branched rays; tip of adpressed not reaching anterior margin of pelvic-fin insertion. Pelvic fin with one unbranched and seven (22) branched rays; tip of adpressed reaching to posterior anus. Anal fin with three unbranched and six (22) branched rays; origin closer to pelvic-fin insertion than to caudal-fin base. Caudal fin deeply forked, with nine branched rays on upper lobes and eight branched rays on lower lobes, lobes pointed, upper lobes slightly more pointed than lower lobes.

Total vertebrae 4+37–38. Gill rakers rudimentary. Pharyngeal teeth "3, 5–5, 3".

Coloration in life. Dorsal side of head and body greyish brown, mid-lateral side shallow greyish yellow, and ventral side grayish white. Dorsal side of body with 5–6 black crossbars (first at posterior of head, second at dorsal-fin base origin, third at posterior of dorsal-fin base, fourth at vertical position above anal-fin base origin, fifth and sixth on caudal peduncle, respectively). Flank with 7–9 black blotches; margin of scales on back and flank slightly black pigmented. One slightly fluorescent yellowish-green stripe extends above lateral line. One distinct black stripe between anterior orbit and snout. Fins translucent, with slightly black pigments on dorsal fin, pectoral fin, and caudal fin rays; fins without black spots (Fig. 2B).

Figure 2. General view of *Gobio huanghensis*. **A.** Preserved specimen, ASIZB 242040, 88.6 mm SL; **B.** Freshly caught individual, uncatalogued, Fengjiachuan Township, Baode County, Xinzhou City, Shanxi Province, from the main stream of the Yellow River.

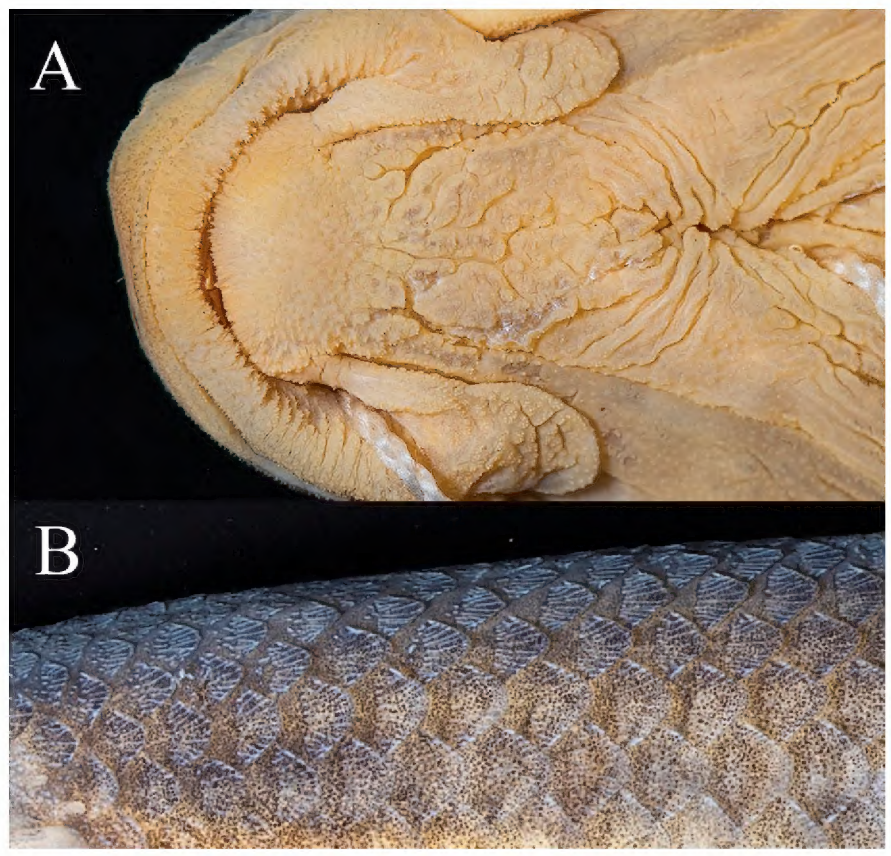

Figure 3. Mouth and pre-dorsal region of *Gobio huanghensis*. **A.** Tiny papillae on lips, lateral lobes, and chin; **B.** Epithelial crests on pre-dorsal region scales. Photographed by Yiyang Xu.

Coloration in preservation. Dorsal side of head and body yellowish grey, mid-lateral side shallow yellowish grey, and ventral side greyish white. Dorsal side of body with 5–6 black crossbars in same position as live individual. Flank with 7–9 dark grey blotches, first three or four blotches vague. Margin of scales on back and flank slightly black pigmented. The fluorescent yellowish-green stripe faded. One distinct black stripe between anterior orbit and snout. Fins pale, with slightly black pigments on dorsal fin, pectoral fin, and caudal fin rays; fins without black spots. The black pigments on fin rays faded after long-time preserve.

Sexual dimorphism. No sexual dimorphism observed.

Distribution. *Gobio huanghensis* is distributed in the main stream of the Yellow River drainage, from Lanzhou City, Gansu Province, to Yongji City, Yuncheng City, and Shanxi Province (Fig. 4A).

Habitat and biology. *Gobio huanghensis* inhabits the main stream of the Yellow River. It usually appears in fast-flowing water with sandy bottoms and high turbidity, which is caused by fine sediments. It feeds in sand on the bottom of the river.

Remarks. *Gobio tchangi* was originally described by Li (2015). In the original description, *G. tchangi* is said to resemble *G. huanghensis*, the only difference between the two species being the location of the anus (3.5 scales from anus to anal-fin base in *G. tchangi* vs. 5 scales in *G. huanghensis*). However, after carefully measuring specimens of both *G. tchangi* and *G. huanghensis*, the 3.5 scales from the anus to the anal-fin base in *G. tchangi* were found to be incorrect. The holotype of *G. tchangi* (ASIZB 56774, Fig. 5A) has 5 scales between the anus and anal-fin base, and other specimens of *G. tchangi* (ASIZB 56773, 56775–56778) also had 5–6 scales between the anus and the anal-fin base. Additionally, the scales between the anus and anal-fin base are not neatly aligned, making this an unreliable taxonomic trait. Therefore, we use the pelvic fin-anus distance and anus-anal fin distance to measure the position of the anus. The position of the anus did not differ between the two nominal species (pelvic fin-anus distance averaged 94.0% of anus-anal fin distance in *G. tchangi*, compared to 98.1% in *G. huanghensis*).

To further compare the morphological difference between *Gobio huanghensis* and *G. tchangi*, a PCA based on 22 specimens, including the holotype *of G. tchangi*, was generated. The first three components contributed 98.3% of the variance. Principal component 1 (PC 1) primarily represents the body size of the specimens, while PC 2 and PC 3 reflect their morphology. PCA loadings (Table 3) indicate that body depth, pelvic-fin base length, and anal-fin base length contribute most to PC 2. Even these characters have high loadings; *G. huanghensis* and *G. tchangi* were not separated in PC 2 or in PC 3 (Fig. 6).

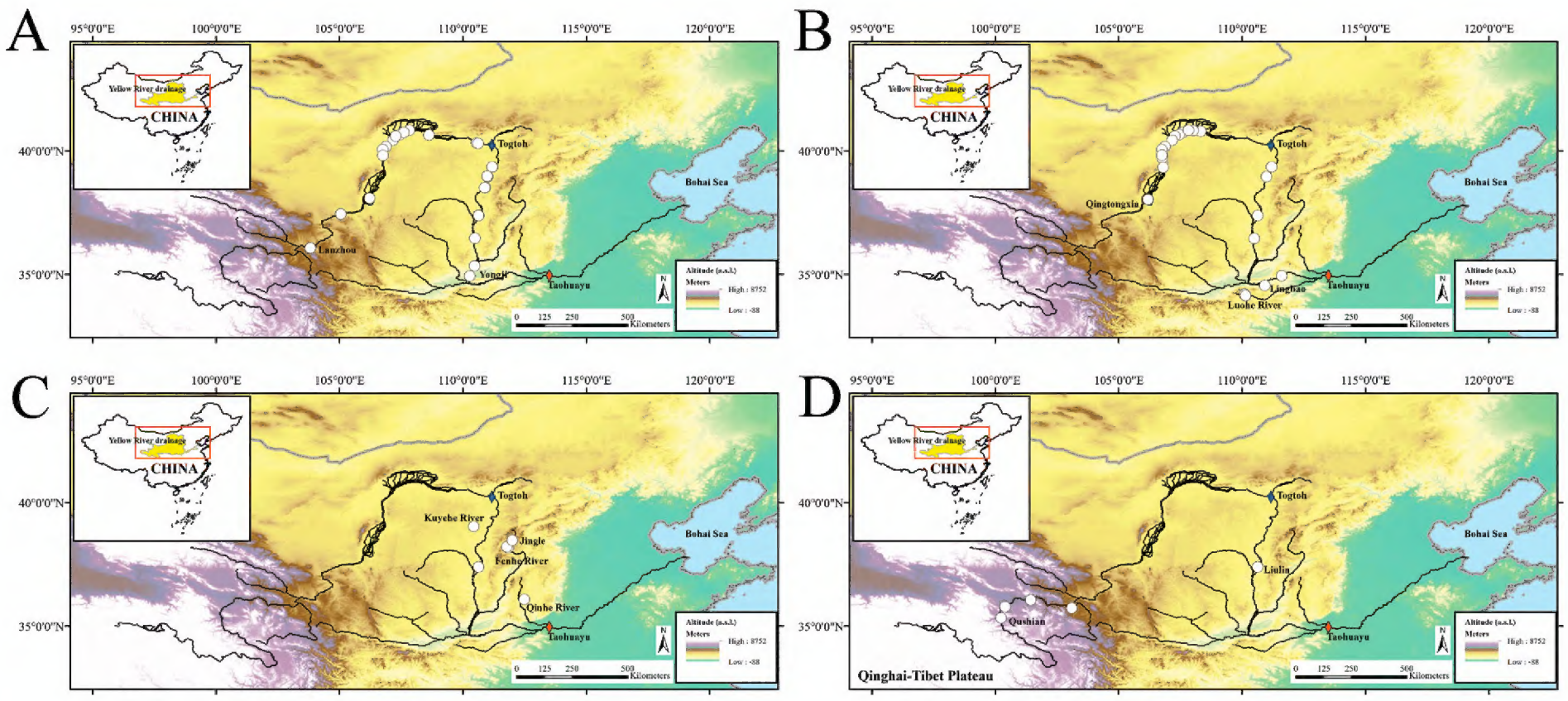

Figure 4. The distribution of the four *Gobio* species in the Yellow River drainage. **A.** *Gobio huanghensis*; **B.** *Gobio rivuloides*; **C.** *Gobio coriparoides*; **D.** *Gobio guentheri*.

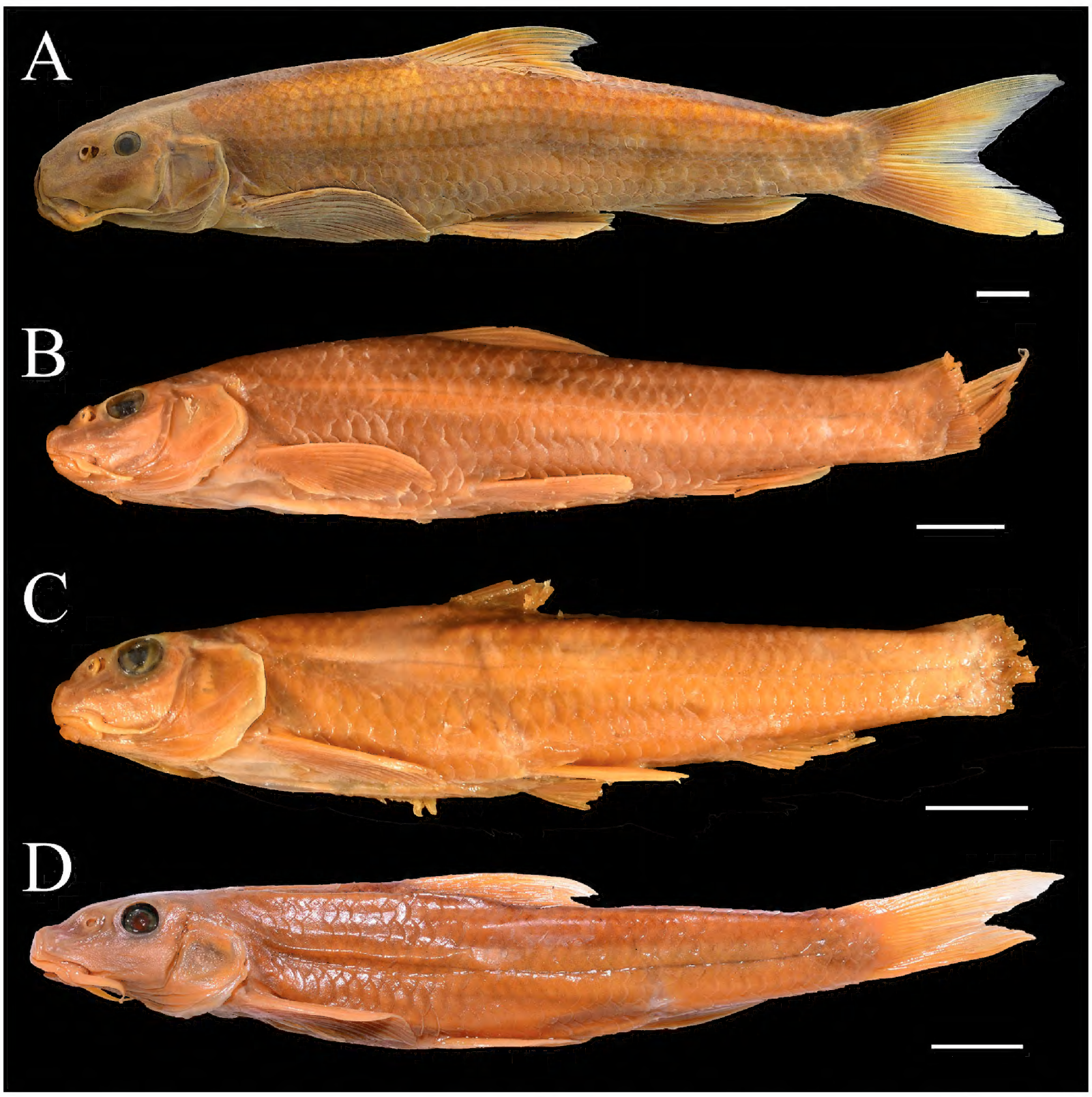

Figure 5. The type specimens of four invalid *Gobio* species in the Yellow River drainage. **A.** *Gobio tchangi* (= *G. huanghensis*), holotype, ASIZB 56774, 152.8 mm SL, photographed by Xueyuan Li; **B.** *Romanogobio johntreadwelli* (= *G. rivuloides*), holotype, AMNH 29694, 93.7 mm SL, photographed by Ryan J. Thoni; **C.** *Romanogobio amplexilabris* (= *G. rivuloides*), holotype, AMNH 29696, 80.6 mm SL, photographed by Ryan J. Thoni; **D.** *Gobio meridionalis* (= *G. rivuloides*), paratype, IHB 81–7–1997, 88.6 mm SL; photographed by Zhixian Sun.

Table 2. Morphometric measurements of *Gobio* species in the Yellow River drainage.

Characters	*Gobio huanghensis* (n = 17)			*Gobio tchangi* (n = 6)				*Gobio rivuloides* (n = 10)		
				Holotype	Holotype + Other Specimens					
	Range	Mean	SD		Range	Mean	SD	Range	Mean	SD
Dorsal-fin rays	7	7		7	7	7		7	7	
Anal-fin rays	6	6		6	6	6		6–7	6	
Pectoral-fin rays	13–14	14		14	13–14	14		13–14	14	
Pelvic-fin rays	7	7		7	7	7		7	7	
Lateral line scales	42–44	43		43	41–43	42		40–43	42	
Scales above lateral line	6–7.5	6.5		6.5	6–6.5	6.5		5.5–7.5	6	
Scales below lateral line	3–4	4		4	4	4		3–4	3	
Circumpeduncular scales	14–16	16		14	14–16	16		14–16	14	
SL (mm)	64.7–128.9			152.8	115.6–157.6			66.9–119.2		
In percent of SL										
Body depth	18.0–24.1	21.2	1.7	21.0	16.5–21.0	18.8	1.8	19.0–22.8	20.5	1.5
Dorsal-fin base length	13.0–15.7	14.3	0.7	13.9	13.8–15.2	14.4	0.6	13.5–15.1	14.5	0.5
Pectoral-fin base length	4.2–5.8	5.2	0.5	6.4	4.8–6.4	5.8	0.6	4.5–6.6	5.7	0.6
Pelvic-fin base length	3.9–5.7	4.7	0.6	5.1	4.4–5.1	4.7	0.3	3.9–5.6	4.8	0.6
Anal-fin base length	9.1–10.5	9.9	0.4	10.8	10.2–11.5	10.7	0.4	8.6–10.8	9.3	0.7
Pre-dorsal length	43.8–48.7	46.8	1.5	45.9	44.9–46.3	45.9	0.5	41.7–49.9	45.8	2.6
Pre-pectoral length	23.7–25.6	24.5	0.6	23.3	23.3–25.1	24.0	0.7	23.3–33.7	25.8	2.9
Pre-pelvic length	47.1–51.2	48.7	1.1	48.3	47.2–50.3	48.7	1.3	45.2–51.1	48.1	1.8
Pre-anal length	68.8–73.8	71.5	1.3	71.1	70.2–73.5	71.4	1.5	69.7–73.4	71.2	1.1
Post-dorsal length	52.7–58.5	56.8	1.3	56.4	55.8–58.8	57.0	1.0	54.1–62.0	57.7	2.8
Caudal peduncle length	18.8–22.1	20.0	0.8	19.0	18.3–19.6	19.1	0.5	22.3–17.8	20.2	1.5
Caudal peduncle depth	9.0–12.2	9.9	0.7	9.8	8.8–9.8	9.1	0.4	8.3–11.5	9.6	1.0
Head length (mm)	16.4–32.0			36.1	27.7–36.7			16.9–27.5		
In percent of HL										
Head depth	53.0–62.6	55.7	2.7	59.9	54.1–62.2	57.6	3.1	55.7–62.4	58.7	2.1
Head width	53.4–64.1	59.9	3.3	61.9	53.2–70.3	60.3	6.1	58.8–65.3	62.4	2.2
Eye diameter	20.8–27.0	23.3	1.8	20.4	19.8–22.3	21.1	0.9	24.7–32.1	27.6	2.1
Interorbital width	20.4–27.1	23.3	1.7	22.7	21.9–24.5	23.2	1.0	18.4–24.7	21.9	1.9
Snout length	34.8–46.6	41.2	3.2	43.6	39.4–43.6	42.1	1.4	33.4–39.4	35.6	1.7
Barbel length	41.3–57.1	47.3	4.7	45.3	45.3–58.2	51.5	4.3	31.8–39.9	36.3	2.9

	Gobio meridionalis (n = 24)						*Gobio coriparoides* (n = 15)			*Gobio guentheri* (n = 11)		
	Paratypes (n = 6)			Other specimens (n = 18)								
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
Dorsal-fin rays	7	7		7	7		7	7		7	7	
Anal-fin rays	6	6		6	6		6	6		6	6	
Pectoral-fin rays	14–15	14		13–15	13		14–15	14		14–15	15	
Pelvic-fin rays	7	7		7	7		7	7		7	7	
Lateral line scales	40–42	42		41–43	42		39–41	40		40–43	42	
Scales above lateral line	5.5	5.5		5.5	5.5		6.5–7.5	6.5		5–8	7	
Scales below lateral line	3	3		2–3	3		4–5	4		4	4	
Circumpeduncular scales	12	12		12–14	12		16–18	18		20–24	20	
SL (mm)	60.0–88.6			72.1–109.1			60.0–81.8			69.0–143.4		
In percent of SL												
Body depth	17.7–21.8	19.4	1.5	18.6–22.5	20.6	1.1	22.6–26.8	25.5	1.2	21.4–30.1	26.5	2.6
Dorsal-fin base length	12.7–15.2	13.8	0.9	13.4–15.1	14.2	0.4	13.1–16.1	14.9	1.0	14.0–16.7	15.2	0.7
Pectoral-fin base length	5.2–6.9	6.2	0.7	4.9–6.3	5.6	0.4	4.8–6.9	5.7	0.6	5.5–7.1	6.2	0.5
Pelvic-fin base length	3.8–5.7	4.6	0.6	4.3–5.6	5.0	0.3	4.3–6.1	5.3	0.5	5.3–7.3	6.0	0.6
Anal-fin base length	8.1–9.7	8.9	0.7	8.6–9.9	9.3	0.4	9.1–11.2	10.1	0.6	9.3–11.3	10.3	0.6
Pre-dorsal length	42.5–46.3	44.5	1.2	42.8–46.7	44.1	0.9	44.8–48.6	46.7	1.2	45.7–49.6	47.8	1.1
Pre-pectoral length	23.8–27.1	25.6	1.2	22.0–25.3	23.7	0.8	24.3–27.3	25.7	0.9	24.3–27.4	25.6	0.9
Pre-pelvic length	47.4–50.9	49.3	1.2	47.4–50.6	49.1	1.0	45.8–48.7	47.3	0.8	47.2–50.5	48.9	1.2
Pre-anal length	68.7–74.9	72.1	2.4	69.3–73.8	72.0	1.3	68.5–72.6	70.2	1.2	70.9–76.6	73.3	1.9
Post-dorsal length	55.5–58.8	56.7	1.2	56.4–61.7	58.3	1.2	55.5–58.3	56.7	0.9	53.7–57.8	56.0	1.3
Caudal peduncle length	15.6–19.7	18.1	1.4	17.9–21.3	19.7	0.9	18.0–23.7	21.0	1.3	17.3–20.9	19.3	1.1
Caudal peduncle depth	9.1–10.0	9.8	0.3	8.8–10.3	9.5	0.6	11.4–13.5	12.3	0.6	10.7–13.9	12.8	1.1
Head length (mm)	14.6–23.6			17.6–24.8			14.9–20.8			16.3–34.3		
In percent of HL												
Head depth	50.8–60.4	55.8	3.8	52.7–65.6	58.0	2.8	61.0–69.4	65.2	2.1	54.6–64.5	60.6	3.3
Head width	47.1–60.5	53.2	4.6	53.2–74.8	62.4	5.2	63.2–72.4	66.9	2.7	55.1–65.9	61.4	3.8
Eye diameter	20.9–26.4	24.4	2.3	23.7–29.1	25.7	1.3	24.6–29.3	27.0	1.4	22.1–28.6	24.5	2.1
Interorbital width	24.4–29.6	27.2	2.0	23.5–29.3	26.1	1.4	24.0–32.6	29.9	2.2	24.9–30.4	27.3	2.2
Snout length	35.1–43.2	38.3	3.9	31.9–37.7	34.4	1.6	27.6–33.6	30.4	1.7	29.9–36.9	34.2	2.3
Barbel length				31.1–39.5	35.5	2.3	30.4–41.2	35.7	3.4	53.3–89.4	72.1	10.7

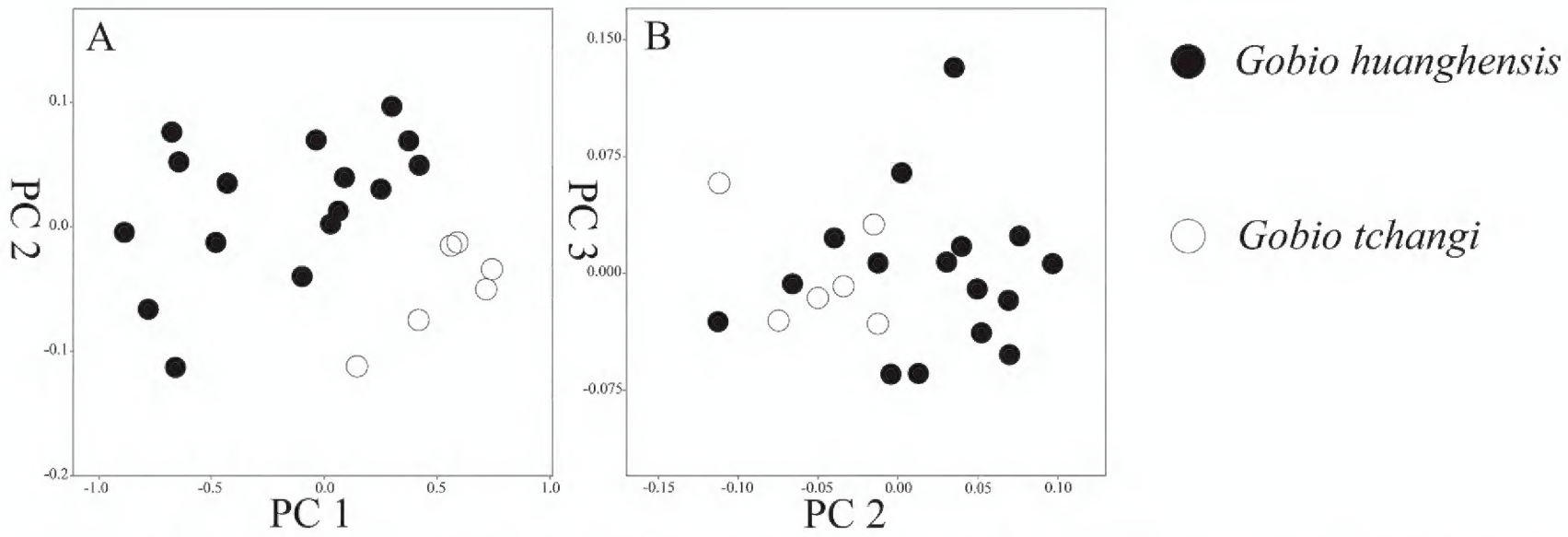

Figure 6. A. Scatterplot of PC1 against PC2 and **B.** PC2 against PC3 extracted from 19 morphometric data of *Gobio huanghensis* and *Gobio tchangi*.

Table 3. Loadings on the first three principal components extracted from morphometric data of *Gobio huanghensis* and *G. tchangi*.

Morphometric measurements	PC 1	PC 2	PC 3
Standard length	0.235	–0.046	–0.015
Body depth	0.222	0.579	0.100
Head length	0.217	0.037	–0.029
Head depth	0.226	0.160	0.128
Head width	0.235	0.235	–0.227
Dorsal-fin base length	0.223	–0.135	0.272
Pectoral-fin base length	0.278	–0.265	–0.710
Pelvic-fin base length	0.220	–0.571	0.327
Anal-fin base length	0.242	–0.294	0.208
Caudal peduncle length	0.218	–0.041	–0.102
Caudal peduncle depth	0.214	0.211	0.292
Eye diameter	0.155	0.071	–0.095
Interorbital width	0.234	0.121	0.180
Snout length	0.244	–0.001	–0.202
Pre-dorsal length	0.237	0.072	–0.099
Pre-pectoral length	0.228	0.028	0.023
Pre-pelvic length	0.237	–0.002	0.058
Pre-anal length	0.238	0.010	0.018
Post-dorsal distance	0.235	–0.078	0.036

Additionally, the type locality of *Gobio tchangi* is Lanzhou City, Gansu Province, which is the same as that of *G. huanghensis*. Based on the morphological comparisons and distribution, we treat *G. tchangi* as a junior synonym of *G. huanghensis*.

Gobio rivuloides Nichols, 1925

Figs 7, 8, Table 2

Gobio rivuloides Nichols, 1925: 5.
Gobio (*Romanogobio*) *johntreadwelli*: Bănărescu & Nalbant (1973): 145.
Gobio (*Romanogobio*) *amplexilabris*: Bănărescu & Nalbant (1973): 147.
Gobio meridionalis: Chen et al. (1987): 119.
Romanogobio johntreadwelli: Naseka (1996): 160.
Romanogobio amplexilabris: Naseka (1996): 160.
Romanogobio rivuloides: Naseka (1996): 160.

Material examined. • AMNH 8420 (Holotype), 1 specimen, 133.5 mm SL; Niang-tze-kwan, Shansi (=Niangziguan Township, Pingding County, Yangquan City, Shanxi Province), collected by C. H. Pope. AMNH 29694, 1 specimen, 93.7 mm SL; Linfen City, Shanxi Province, from the Qingshuihe River, a tributary of the Yellow River drainage. • AMNH 29696, 1 specimen, 80.6 mm SL; Linfen City, Shanxi Province, from the Qingshuihe River, a tributary of the Yellow River drainage. IHB 81–7–1981, 81–7–1983, 81–7–1984, 81–7–1985, 81–7–1987, 81–7–1997, 6 specimens, 60.0–88.6 mm SL; Lingbao City, Sanmenxia City, Henan Province, from the Hongnongjian River. • ASIZB 241458, 1 specimen, 109.1 mm SL; Hequ County, Xinzhou City, Shanxi Province, from the main stream of the Yellow River (39.3502°N, 111.1931°E, ca 840 m a.s.l.); collected by Yutian Fang, 17 October 2023. • ASIZB 241459, 1 specimen, 96.9 mm SL; Xing County, Lvliang City, Shanxi Province, from the main stream of the Yellow River (38.5145°N, 110.8782°E, ca 760 m a.s.l.); collected by Xin Wang, 2 March 2022. • ASIZB 242016–242018, 3 specimens, 84.5–100.2 mm SL, Wuhai City, Inner Mongolia Autonomous Region, from the main stream of the Yellow River (39.7124°N, 106.7635°E, ca 1060 m a.s.l.); collected by Junyuan Hao, 11 May 2024. • ASIZB 241457, 1 specimen, 82.5 mm SL; Pingshan County, Shijiazhuang City, Hebei Province, from the Hutuohe River (38.3994°N, 113.6947°E, ca 280 m a.s.l.); collected by Zhixian Sun, 6 July 2023. • ASIZB 215395, 1 specimen, 70.3 mm SL; Yangyuan County, Zhangjiakou City, Hebei Province, from the Sangganhe River (40.1735°N, 114.5267°E, ca 820 m a.s.l.); 20 October 2019. • ASIZB 239685–239687, 3 specimens, 73.7–98.9 mm SL; Shangyi County, Zhangjiakou City, Hebei Province, from the Yanghe River (40.8887°N, 114.2029°E, ca 1040 m a.s.l.); collected by Chen Tian, 2 October 2023. • ASIZB 242027–242028, 242042, 3 specimens, 66.9–77.9 mm SL; Luonan County, Shangluo City, Shaanxi Province, from the Luohe River, a tributary of the Yellow River drainage (34.1927°N, 110.0943°E, ca 1010 m a.s.l.); collected by Yutian Fang, 28 May 2024. • ASIZB 242043–242046, 4 specimens, 87.8–93.9 mm SL; Qingtongxia City, Wuzhong County, Ningxia Hui Autonomous Region, from the main stream of the Yellow River (38.0387°N, 106.1837°E, ca 1130 m a.s.l.); collected by Junyuan Hao, 4 August 2024. • ASIZB 242047–242051, 5 specimens, 72.1–92.0 mm SL; Hangjin Banner, Ordos City, Inner Mongolia Autonomous Region,

Figure 7. *Gobio rivuloides*, holotype, AMNH 8420, 133.5 mm SL. **A.** Dorsal view; **B.** Lateral view; **C.** Ventral view; photographed by Ryan J. Thoni.

from the main stream of the Yellow River (40.8379°N, 107.8308°E, ca 1030 m a.s.l.); collected by Junyuan Hao, 30 July 2024. • ASIZB 242052–242055, 4 specimens, 75.8–85.1 mm SL; Bohaiwan County, Wuhai City, Inner Mongolia Autonomous Region, from the main stream of the Yellow River (39.8317°N, 106.7551°E, ca 1070 m a.s.l.); collected by Junyuan Hao, 27 July 2024. • ASIZB 242056–242057, 2 specimens, 118.3–119.2 mm SL; Huailai County, Zhangjiakou City, Hebei Province, from the Yanghe River, a tributary of the Haihe River drainage (40.3804°N, 115.3630°E, ca 490 m a.s.l.); collected by Chen Tian, 28 July 2023.

Vouchers for molecular study. ASIZB 219283, 1 specimen, Huguan County, Changzhi City, Shanxi Province, from the Xihe River, a tributary of the Haihe River drainage (35.9271°N, 113.6309°E, ca 540 m a.s.l.); collected by Zhixian Sun, 2 September 2020. ASIZB 239687, 1 specimen, Shangyi County, Zhangjiakou City, Hebei Province, from the Yanghe River, a tributary of the Haihe River drainage (40.8887°N, 114.2029°E, ca 1040 m a.s.l.); collected by Chen Tian, 2 October 2023. ASIZB 241457, 1 specimen, Pingshan County, Shijiazhuang City, Hebei Province, from the Hutuohe River, a tributary of the Haihe River drainage (38.3994°N, 113.6947°E, ca 280 m a.s.l.); collected by Zhixian Sun, 6 July 2023. ASIZB 242027–242028, 2 specimens, Luonan County, Shangluo City, Shaanxi Province, form the Luohe River, a tributary of the Yellow River drainage (34.1927°N, 110.0943°E, ca 1010 m a.s.l.); collected by Yutian Fang, 28 May 2024. ASIZB 241459, 1 specimen, Xing County, Lvliang City, Shanxi Province, from the main stream of the Yellow River (38.5145°N, 110.8782°E, ca 760 m a.s.l.); collected by Xin Wang, 2 March 2022. ASIZB 242016, 242018, 2 specimens, Wuhai City, Inner Mongolia Autonomous Region, from the main stream of the Yellow River (39.7124°N, 106.7635°E, ca 1060 m a.s.l.); collected by Junyuan Hao, 11 May 2024. ASIZB 242062, 1 specimen, Daning County, Linfen City, Shanxi Province, from the main stream of the Yellow River (36.4587°N, 110.4876°E, ca 600 m a.s.l.); collected by Zhixian Sun, 8 July 2024.

Diagnosis. This species can be distinguished from other *Gobio* species in the Yellow River drainage by following characteristics: barbel reaching between vertical position of posterior orbit and posterior preopercle margin (vs. reaching beyond posterior preopercle margin in *G. huanghensis* and *G. guentheri*); lateral-line scales 40–43 (mode 42, mean 42) (vs. mean 40 in *G. coriparoides*); circumpeduncular scales 12–16 (mode 12, mean 12) (vs. more than 16 in *G. huanghensis*, *G. coriparoides*, and *G. guentheri*); longitudinal epithelial crests present on pre-dorsal scales (vs. absent in *G. coriparoides* and *G. guentheri*); anus centrally located between pelvic-fin base and anal-fin origin or closer to pelvic-fin base (vs. positioned at posterior one-third of distance from pelvic-fin base end to anal fin origin in *G. coriparoides* and *G. guentheri*).

Redescription. Body elongated, dorsal body profile rising from nostrils to dorsal-fin origin, dropping along dorsal-fin base, then gradually sloping to caudal-fin base. Maximum body depth at dorsal-fin origin. Head relative

Figure 8. General view of *Gobio rivuloides*. **A.** Preserved specimen, ASIZB 242042, 66.9 mm SL; **B.** Same individual in life.

elongated, length slightly larger than body depth; snout relative elongated. Mouth horseshoe-shaped and inferior, with one pair of maxillary barbels root at extremity of upper lip, barbel relative elongated, reaching from vertical position of posterior orbit to posterior preopercle margin. Lips thin, lower lip fused with throat; lips connected at mouth corner. Eyes positioned on dorsal half of head; interorbital region flattened; width almost equal to eye diameter. Thoracic region flattened, abdomen rounded, caudal peduncle robust, compressed laterally. Anus centrally located between pelvic-fin base and anal-fin origin or closer to pelvic-fin base.

Body covered with moderately large cycloid scales. Lateral line complete, almost straight in lateral center. Lateral line scales 40 (4 specimens), 41 (9), 42 (17), 43 (4); scales above lateral line 5.5 (27), 6 (3), 6.5 (3), 7.5 (1); scales below lateral line 2 (1), 3 (30), 4 (3); circumpeduncular scales 12 (23), 14 (9), 16 (2). Longitudinal epithelial crests present on pre-dorsal region scales; the ventral scaleless region extends to middle of pectoral-fin base and to pelvic-fin base.

Dorsal fin with three unbranched and seven (34 specimens) branched rays; distal margin concave, origin closer to snout than caudal-fin base. Pectoral fin with one unbranched and 13 (15), 14 (16), and 15 (3) branched rays; tip of adpressed not reaching anterior margin of pelvic-fin insertion. Pelvic fin with one unbranched and seven (34) branched rays; tip of adpressed reaching to posterior anus. Anal fin with three unbranched and six (33), seven (1) branched rays; origin closer to pelvic-fin insertion than to caudal-fin base. Caudal fin deeply forked, with nine branched rays on upper lobes and eight branched rays on lower lobes, lobes pointed, upper lobes slightly more pointed than lower lobes.

Total vertebrae 4+34–36. Gill rakers rudimentary. Pharyngeal teeth "3, 5–5, 3".

Coloration in life. Dorsal side of head and body brownish yellow, mid-lateral side shallow brownish yellow, and ventral side grayish white. Dorsal side of body with 5–6 black crossbars (first at posterior of head, second at dorsal-fin base origin, third at posterior of dorsal-fin base, fourth at vertical position above anal-fin base origin, fifth and sixth on caudal peduncle, respectively). Flank with 7–10 black blotches; margin of scales on back and flank black pigmented. One slightly fluorescent yellowish-green stripe extends above lateral line. One distinct black stripe between anterior orbit and snout. Fins translucent, dorsal fin, pectoral fin, pelvic fin, and caudal fin with some black spots (Fig. 8B). The specimens collected in the main stream of the Yellow River have paler color and less black spots than those specimens that were collected from the tributaries. We assume that because the water from the main stream of the Yellow River is more turbid (caused by sand), the fish present lighter colors.

Coloration in preservation. Dorsal side of head and body greyish brown, mid-lateral side greyish yellow, and ventral side greyish white. Dorsal side of body with 5–6 black crossbars in same position as live individual. Flank with 7–10 dark grey blotches, first three or four blotches vague. Margin of scales on back and flank black pigmented. The fluorescent yellowish-green stripe faded. One distinct black stripe between anterior orbit and snout. Fins pale, dorsal fin, pectoral fin, pelvic fin, and caudal fin with some black spots. The color of specimens that were

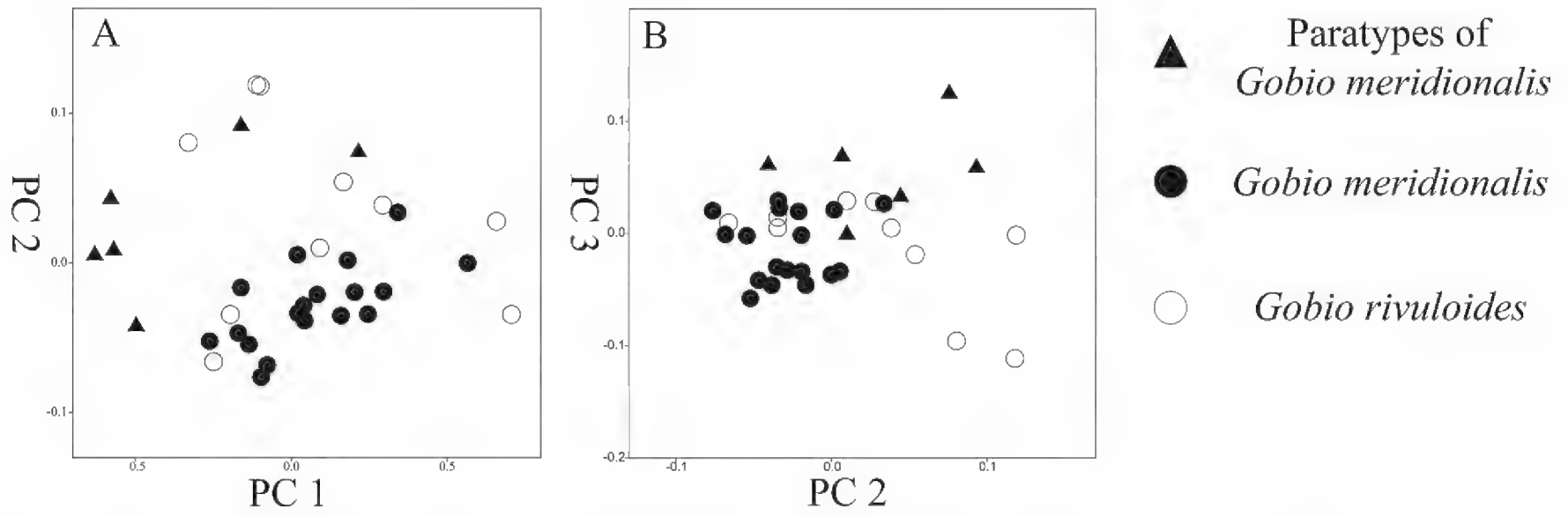

Figure 9. A. Scatterplot of PC1 against PC2 and **B.** PC2 against PC3 extracted from 19 morphometric data of *Gobio meridionalis* and *G. rivuloides*.

collected in mainstream of the Yellow River could be lighter, dorsal side of head and body shallow greyish yellow, mid-lateral and ventral sides greyish white. Dorsal side of body with 5–6 shallow black crossbars in same position as live individual. The blotches on flank vague, merge into a shallow dark stripe from posterior head to caudal peduncle end. Margin of scales on back and flank slightly black pigmented. The fluorescent yellowish-green stripe faded. One distinct black stripe between anterior orbit and snout. Fins pale, with slightly black pigments on dorsal fin, pectoral fin, and caudal fin rays; fins without black spots. The black pigments on fin rays faded after long-time preserve.

Sexual dimorphism. No sexual dimorphism observed.

Distribution. *Gobio rivuloides* is widely distributed in the Yellow River drainage and the Haihe River drainage. In the Yellow River drainage, this species is distributed in both the mainstream, from Qingtongxia City to Lingbao City, and the tributaries, such as the Luohe, Qijiahe, Qinhe, and Hongnongjian Rivers, etc. (Fig. 4B).

Habitat and biology. *Gobio rivuloides* inhabits both the main stream and the tributaries of the Yellow River. It usually appears in fast-flowing water with sandy bottoms with gravel and pebbles. It feeds on the bottom of the river.

Remarks. *Romanogobio johntreadwelli* and *R. amplexilabris* were originally described by Bănărescu and Nalbant (1973) in the subgenus *Romanogobio* under the genus *Gobio*. This subgenus was treated as a genus in the subsequent studies (e.g., Naseka 1996). Naseka (1996) put these species into the genus *Romanogobio*. The type locality of these species is the Qingshuihe River, a tributary of the Yellow River drainage in Shanxi Province. We tried to collect more topotypes of these two species, but unfortunately, the habitat of the type locality has been degraded and the river has dried up. We examined the holotype (Fig. 5B, C) and paratypes of both species. The specimens have 40–42 lateral line scales, scales above lateral line 5.5, scales below lateral line 3, circumpeduncular scales 12, the anus positioned at middle of the pelvic-fin base end to the anal-fin origin or closer to the pelvic-fin base, a total of vertebrae 4+35, and a barbel relative elongated, reaching from vertical position of posterior orbit to posterior preopercle margin. All of the characters described above agree with those of *Gobio rivuloides*. *Romanogobio johntreadwelli* and *R. amplexilabris* are junior synonyms of *G. rivuloides*.

Gobio meridionalis (Fig. 5D) was originally described by Xu in Chen et al. (1987). According to the original description, this species is similar to *G. rivuloides*, but it has 12 circumpeduncular scales (vs. 14 in *G. rivuloides*) and lacks black spots on its body. Following this original description, we identified some specimens as *G. meridionalis*. We measured a series of characters of *G. meridionalis* (including the paratypes) and *G. rivuloides* and then conducted PCA for a detailed comparison. The first three components contributed 94.6% of the variance. Principal component 1 (PC 1) primarily represents the body size of the specimens, while PC 2 and PC 3 reflect their morphology. The PCA loadings presented in Table 4 indicate that pelvic-fin base length, snout length, and pre-pectoral length contribute most to PC 2. Even these characters have high loadings; *G. meridionalis* and *G. rivuloides* could not be separated in PC 2, nor in PC 3. However, neither PC 1 versus PC 2 nor PC 2 versus PC 3 could separate these two species (Fig. 9). The difference in coloration should be related to water turbidity (Kottelat and Persat 2005); the high turbidity of water in the main stream causes the lighter color of *G. meridionalis*, while the low turbidity of water in the tributaries causes the darker coloration and black spots of *G. rivuloides*. The circumpeduncular scales with several traits were also reported in *G. lozanoi* and *G. occitaniae* (Kottelat and Persat 2005). This result indicates that the number of circumpeduncular scales is an unreliable taxonomic characteristic, and the difference between 12 and 14 circumpeduncular scales should not be used to differentiate *G. meridionalis* and *G. rivuloides*.

We sequenced the Cyt *b* gene and reconstructed a phylogenetic tree for species within the genus *Gobio* that inhabit the Yellow River drainage (Fig. 10). The phylogenetic tree shows that *G. meridionalis* is nested within *G. rivuloides*. To maintain the monophyly of *G. rivuloides*, we propose that *G. meridionalis* is a synonym of *G. rivuloides*. Additionally, we calculated the genetic distances for the Cyt *b* gene (Table 5). The genetic

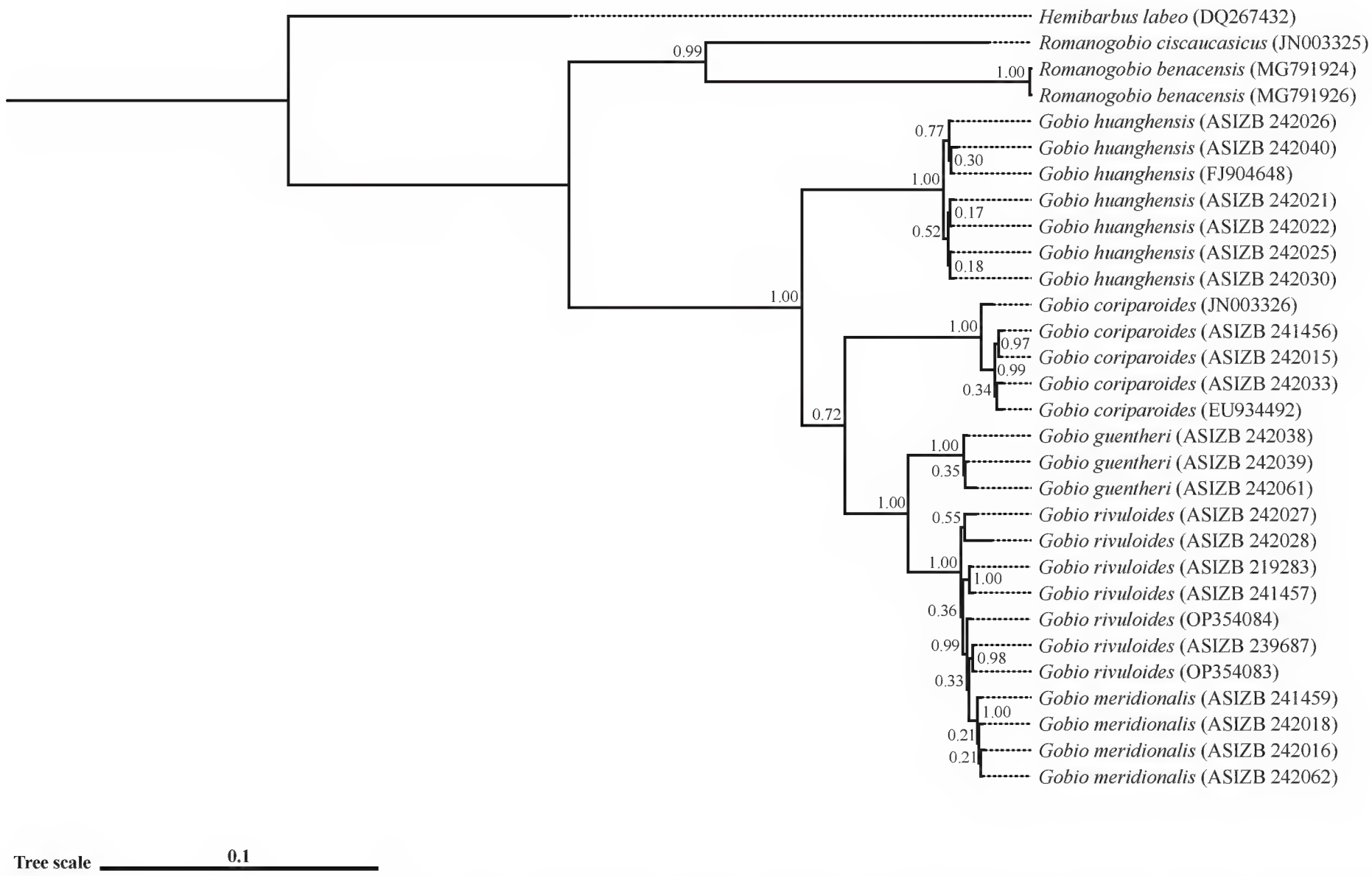

Figure 10. Molecular phylogenetic tree of *Gobio huanghensis*, *G. coriparoides*, *G. guentheri*, *G. rivuloides*, and *G. meridionalis* reconstructed by the Bayesian inference method based on the Cyt *b* sequence (1140 bp).

Table 4. Loadings on the first three principal components extracted from morphometric data of *Gobio meridionalis* and *G. rivuloides*.

Morphometric measurements	PC 1	PC 2	PC 3
Standard length	0.227	–0.059	–0.025
Body depth	0.238	–0.069	–0.147
Head length	0.201	0.205	–0.014
Head depth	0.213	0.201	–0.161
Head width	0.278	0.147	–0.415
Dorsal-fin base length	0.251	–0.051	–0.051
Pectoral-fin base length	0.223	–0.004	0.656
Pelvic-fin base length	0.278	–0.538	0.235
Anal-fin base length	0.258	–0.289	0.083
Caudal peduncle length	0.279	–0.080	–0.158
Caudal peduncle depth	0.216	0.117	0.090
Eye diameter	0.160	–0.105	–0.344
Interorbital width	0.204	0.056	0.142
Snout length	0.211	0.551	0.299
Pre-dorsal length	0.216	0.136	–0.108
Pre-pectoral length	0.192	0.326	0.050
Pre-pelvic length	0.210	–0.002	–0.091
Pre-anal length	0.221	–0.036	–0.023
Post-dorsal distance	0.246	–0.220	–0.004

distance between *G. rivuloides* and *G. meridionalis* is 0.0068, which is comparable to the intraspecific distance of *G. rivuloides* (0.0062). This result further supports *G. meridionalis* to be a junior synonym of *G. rivuloides*.

Naseka (1996) also placed *Gobio rivuloides* in the genus *Romanogobio*. However, phylogenetic analysis (Fig. 10) suggests that *G. rivuloides* should remain within the genus *Gobio*.

Gobio coriparoides Nichols, 1925

Figs 11, 12, Table 2

Gobio coriparoides Nichols, 1925: 4.

Material examined. • AMNH 8418 (Holotype), 1 specimen, 77.8 mm SL; the vicinity of Ningwu, Kolan, and Tsinglo, Shansi (=Ningwu, Kelan and Jingle County, Shanxi Province), collected by C. H. Pope. • ASIZB 232933, 1 specimen, 67.9 mm SL; Liulin County, Lvliang City, Shanxi Province, from the main stream of the Yellow River (37.3891°N, 110.6281°E); 31 July 2022. • ASIZB 241456 (Topotype), 1 specimen, 81.8 mm SL; Jingle County, Xinzhou City, Shanxi Province, from the Fenhe River (38.4726°N, 111.9957°E, ca 1250 m a.s.l.); collected by Dong Sheng, 14 September 2023. • ASIZB 242006–242008, 242009, 242011, 242016, and 242033–242037, 11 specimens, 60.0–73.0 mm SL; Lan County, Lvliang City, Shanxi Province, from the Fenhe River (38.2148°N, 111.7785°E, ca 1150 m a.s.l.); collected by Yutian Fang, 16 May 2024. • ASIZB 242015, 242041 (Topotype), 2 specimens, 68.3–70.7 mm SL, Jingle County, Xinzhou City, Shanxi Province; from the Fenhe River (38.4720°N, 111.9970°E, ca 1260 m a.s.l.); collected by Yutian Fang, 17 May 2024.

Vouchers for molecular study. • ASIZB 241456 (Topotype), 1 specimen, Jingle County, Xinzhou City, Shanxi Province, from the Fenhe River (38.4726°N, 111.9957°E, ca 1250 m a.s.l.); collected by Dong Sheng, 14 September 2023. • ASIZB 242015 (Topotype), 1 specimen, Jingle

Figure 11. *Gobio coriparoides*, holotype, AMNH 8420, 77.8 mm SL. **A.** Dorsal view; **B.** Lateral view; **C.** Ventral view; photographed by Ryan J. Thoni.

County, Xinzhou City, Shanxi Province; from the Fenhe River (38.4720°N, 111.9970°E, ca 1260 m a.s.l.); collected by Yutian Fang, 17 May 2024. • ASIZB 242033, 1 specimen, Lan County, Lvliang City, Shanxi Province, from the Fenhe River (38.2148°N, 111.7785°E, ca 1150 m a.s.l.); collected by Yutian Fang, 16 May 2024.

Diagnosis. This species can be distinguished from other *Gobio* species in East Asia by following characteristics: barbel reaching between vertical position of posterior orbit and posterior preopercle margin (vs. reaching beyond posterior preopercle margin in *G. huanghensis* and *G. guentheri*); lateral-line scales 39–41 (mode 40, mean 40) (vs. more than 40 in *G. huanghensis*, *G. rivuloides* and *G. guentheri*); circumpeduncular scales 16–20 (mode 18, mean 18) (vs. lesser than 16 in *G. rivuloides*); anus positioned at posterior one-third of distance from pelvic-fin base end to anal-fin origin (vs. anus centrally located between pelvic-fin base and anal-fin origin in *G. huanghensis* and *G. rivuloides*).

Redescription. Body relative abbreviated, dorsal body profile rising from nostrils to dorsal-fin origin, dropping along dorsal-fin base, then gradually sloping to caudal-fin base. Maximum body depth at dorsal-fin origin. Head relative abbreviated, length equal to body depth; snout obtuse. Mouth horseshoe-shaped and inferior, with one pair of maxillary barbels root at extremity of upper lip, barbel relative elongated, reaching from vertical position of posterior orbit to posterior preopercle margin. Lips thin, lower lip fused with throat; lips connected at mouth corner. Eyes positioned on dorsal half of head; interorbital region flattened; width larger than eye diameter. Thoracic region flattened, abdomen rounded, caudal peduncle robust, compressed laterally. Anus positioned at posterior one-third of distance from pelvic-fin base end to anal-fin origin.

Body covered with moderately large cycloid scales. Lateral line complete, almost straight in lateral center. Lateral line scales 39 (3 specimens), 40 (11), 41 (1); scales above lateral line 6 (4), 6.5 (8), 7 (2), 7.5 (1); scales below lateral line 4 (14), 5 (1); circumpeduncular scales 16 (6), 18 (8), 20 (1). Longitudinal epithelial crests absent on pre-dorsal region scales; the ventral scaleless region of most specimens (9) extends to middle of pectoral-fin base and to pelvic-fin base; other specimens (6) extend to pectoral-fin base.

Dorsal fin with three unbranched and seven (15 specimens) branched rays; distal margin concave, origin closer to snout than caudal-fin base. Pectoral fin with one unbranched and 14 (10), 15 (5) branched rays; tip of adpressed reaching anterior margin of pelvic-fin insertion. Pelvic fin with one unbranched and seven (15) branched rays; tip of adpressed reaching to posterior anus. Anal fin with three unbranched and six (15) branched rays; origin closer to pelvic-fin insertion than to caudal-fin base. Caudal fin deeply forked, with nine branched rays on upper lobes and eight branched rays on lower lobes, lobes rounded, upper lobes slightly more pointed than lower lobes.

Total vertebrae 4+35. Gill rakers rudimentary. Pharyngeal teeth “3, 5–5, 3”.

Figure 12. General view of *Gobio coriparoides*. **A.** Preserved specimen, ASIZB 242041, 68.3 mm SL; **B.** Live individual, uncatalogued, Duanjiazhai Township, Jingle County, Xinzhou City, Shanxi Province, from the Fenhe River.

Coloration in life. Dorsal side of head and body yellowish brown, mid-lateral side shallow yellowish grey, and ventral side grayish white. Dorsal side of body without black crossbars. Flank with 8–12 vague black blotches; margin of scales on back and flank slightly black pigmented. One slightly fluorescent yellowish-green stripe extends above lateral line. One distinct black stripe between anterior orbit and snout. Fins translucent, with slightly black pigments on dorsal fin, pectoral fin, and caudal fin rays; fins without black spots (Fig. 12B).

Coloration in preservation. Dorsal side of head and body brownish grey, mid-lateral side shallow brownish grey, and ventral side greyish white. Dorsal side of body with one dark stripe from posterior head to caudal peduncle end. Small blotches on flank vague, merge into a dark stripe. Margin of scales on back and flank slightly black pigmented. The fluorescent yellowish-green stripe faded. One distinct black stripe between anterior orbit and snout. Fins pale, with slightly black pigments on dorsal fin, pectoral fin, and caudal fin rays; fins without black spots. The black pigments on fin rays faded after long-time preserve.

Sexual dimorphism. No sexual dimorphism observed.

Distribution. *Gobio coriparoides* is mainly distributed in the tributaries of the Yellow River drainage, such as the Fenhe, Kuyehe, and Qinhe Rivers, etc. It is rarely found in the mainstream of the Yellow River (Fig. 4C).

Habitat and biology. *Gobio coriparoides* inhabits the tributaries of the Yellow River. It usually appears in fast-flowing water with sandy bottoms mixed with gravel and pebbles. It feeds on the bottom of the river.

Gobio guentheri (Herzenstein, 1892)

Fig. 13, Table 2

Acanthogobio guentheri Herzenstein, 1892: 228.
Gobio guentheri: Tang et al. (2011): 103.

Material examined. • ASIZB 78479–78487, 9 specimens, 104.7–143.4 mm SL, Guide County, Hainan Tibetan Autonomous Prefecture, Qinghai Province, from the main stream of the Yellow River, 1958. • ASIZB 242038–242039, 2 specimens, 69.0–81.3 mm SL; Jishishan Bonan, Dongxiang and Salar Autonomous County, Linxia Hui Autonomous Prefecture, Gansu Province, from the Yinchuanhe River, a tributary of the Yellow River drainage (35.7280°N, 103.0919°E, ca 1750 m a.s.l.), collected by Yutian Fang, 21 April 2024.

Vouchers for molecular study. • ASIZB 242038–242039, 2 specimens, Jishishan Bonan, Dongxiang and Salar Autonomous County, Linxia Hui Autonomous Prefecture, Gansu Province, from the Yinchuanhe River, a tributary of the Yellow River drainage (35.7280°N, 103.0919°E, ca 1750 m a.s.l.), collected by Yutian Fang, 21 April 2024. • ASIZB 242061, 1 specimen, Liulin County, Lvliang City, Shanxi Province, from the main stream of the Yellow River (37.3891°N, 110.6281°E); 31 July 2022.

Diagnosis. This species can be distinguished from other *Gobio* species in the Yellow River drainage by following characteristics: barbel reaching beyond posterior preopercle margin (vs. reaching between vertical position of posterior orbit and posterior preopercle

Figure 13. General view of *Gobio guentheri*. **A.** *Gobio guentheri*, ASIZB 78482, 136.9 mm SL, photographed by Xueyuan Li; **B.** Live individual, uncatalogued, Jishishan Bonan, Dongxiang and Salar Autonomous County, Linxia Hui Autonomous Prefecture, Gansu Province, from the Yinchuanhe River.

margin in *G. rivuloides* and *G. coriparoides*); lateral-line scales 40–43 (mode 42, mean 42) (vs. lesser than 40 in *G. coriparoides*); circumpeduncular scales 20–24 (mode 20, mean 20) (vs. lesser than 20 in *G. huanghensis* and *G. rivuloides*); anus positioned at posterior one-third of distance from pelvic-fin base end to anal-fin origin (vs. anus centrally located between pelvic-fin base and anal-fin origin in *G. huanghensis* and *G. rivuloides*). The second unbranched ray of the dorsal fin forms a stiff spine (vs. the second unbranched ray of the dorsal fin is soft in *G. huanghensis*, *G. rivuloides*, and *G. coriparoides*). No scales on pre-dorsal region (vs. present in *G. huanghensis*, *G. rivuloides*, and *G. coriparoides*), ventral scaleless region extends beyond pelvic-fin base (vs. not extending beyond pelvic-fin base in *G. huanghensis*, *G. rivuloides*, and *G. coriparoides*).

Redescription. Body relative abbreviated, dorsal body profile rising from nostrils to dorsal-fin origin, dropping along dorsal-fin base, then gradually sloping to caudal-fin base. Maximum body depth at dorsal-fin origin. Head elongated, length lesser than body depth; snout relative obtuse, with moderate concavity on top of snout before nostrils. Mouth horseshoe-shaped and inferior, with one pair of maxillary barbels root at extremity of upper lip, barbel elongated, extending over posterior preopercle margin to posterior opercular margin. Eyes positioned on dorsal half of head; interorbital region flattened; width larger than eye diameter. Thoracic region flattened, abdomen rounded, caudal peduncle robust, compressed laterally. Anus positioned at posterior one-third of distance from pelvic-fin base end to anal-fin origin.

Body covered with moderately large cycloid scales. Lateral line complete, almost straight in lateral center. Lateral line scales 40 (1 specimen), 41 (4), 42 (5), 43 (1); scales above lateral line 5 (1), 6 (4), 7 (3), 8 (3); scales below lateral line 4 (11); circumpeduncular scales 20 (7), 22 (3), 24 (1). No scales on pre-dorsal region, skin on pre-dorsal region tiny cortical protuberances. Ventral scaleless region extends beyond pelvic-fin base.

Dorsal fin with three unbranched and seven (11 specimens) branched rays, the second unbranched ray stiff, robust; distal margin concave, origin closer to snout than caudal-fin base. Pectoral fin with one unbranched and 14 (5), 15 (6) branched rays; tip of adpressed not reaching anterior margin of pelvic-fin insertion. Pelvic fin with one unbranched and seven (11) branched rays; tip of adpressed reaching to posterior anus. Anal fin with three unbranched and six (11) branched rays; origin closer to pelvic-fin insertion than to caudal-fin base. Caudal fin deeply forked, with nine branched rays on upper lobes and eight branched rays on lower lobes, lobes pointed, upper lobes slightly more pointed than lower lobes.

Total vertebrae 4+35–36. Gill rakers rudimentary. Pharyngeal teeth "3, 5–5, 3".

Coloration in life. Dorsal side of head and body yellowish grey, mid-lateral side shallow yellowish grey, and ventral side grayish white. Flank with 6–8 vague black blotches; margin of scales on flank black pigmented. One slightly fluorescent yellowish-green stripe extends above lateral line. One distinct black stripe between anterior orbit and snout. Fins translucent, with slightly black pigments on fin rays; fins without black spots (Fig. 13B).

Coloration in preservation. Color of aged specimen preservation in formalin brownish yellow. A series of black dots on upper lateral side, flank with 6–8 vague blotches. Color of specimen preservation in 95% ethanol; dorsal side of head and body grey, mid-lateral side greyish yellow, and ventral side greyish white. A series of black dots on upper lateral side, flank with 6–8 vague blotches. One slightly silvery stripe extends above lateral line, margin of scales on flank black pigmented. Fins pale, without spots and pigmented.

Sexual dimorphism. No sexual dimorphism observed.

Distribution. *Gobio guentheri* is distributed in the upper reaches of the Yellow River drainage from Qushian Township to Liulin County (Fig. 4D).

Habitat and biology. *Gobio guentheri* usually appears in fast-flowing water with sandy bottoms. It feeds in sand on the bottom of the river.

Discussion

Romanogobio is not in the Yellow River drainage

The genus *Romanogobio* was established by Bănărescu (1961) as a subgenus of the genus *Gobio*. The type species of *Romanogobio* is *Gobio kesslerii* Dybowski, 1862, from Europe. This subgenus was treated as a genus in subsequent studies (e.g., Naseka 1996). The species belonging to this genus are characterized by a shallower body and slender caudal peduncle, epithelial crests on scales covering the dorsal half of the body, and an anteriorly positioned anus (Kottelat and Freyhof 2007). Naseka (1996) examined the vertebral column of Gobionidae, and he assigned *Gobio rivuloides*, *G.* (*R.*) *johntreadwelli*, and *G.* (*R.*) *amplexilabris* into the genus *Romanogobio* based on their anus position: the anus is closer to pelvic-fin base, which indicates an increased pre-anal vertebral column count.

Even though the anus position is closer to pelvic-fin base, phylogenetic analysis shows *Gobio rivuloides* remain within the genus *Gobio* (Fig. 10). Additionally, the presence of epithelial crests is also seen in *G. huanghensis* (Fig. 3B). In this situation, i.e., genus characteristics of *Romanogobio* also shown in some *Gobio* species, these characters are not reliable enough for differentiating *Romanogobio* and *Gobio*, especially in East Asia. Therefore, these characteristics should be reconsidered for the genus characteristics of *Romanogobio*.

According to Yang (2005), the divergence time between the genera *Romanogobio* and *Gobio* is estimated to be approximately 19 Mya, while the divergence time between *Gobio* species in East Asia and Europe occurred around 5 Mya. These results indicate that ancestral species dispersed into Europe following the retreat of the ancient Tethys Sea, ultimately giving rise to the modern genus *Romanogobio*. This genus should be a Europe-endemic genus, and East Asia is out of its distribution.

Acanthogobio, a junior synonym of genus *Gobio*

Acanthogobio guentheri was the first species described in the genus *Acanthogobio*. Subsequently, between 1904 and 1908, three other species were described as new within the same genus: *A. oxyrhynchus* (= *Hemibarbus labeo*, Luo et al. 1977), *A. paltschevskii* (= *Hemibarbus maculatus*, Luo et al. 1977), and *A. longirostris* (= *Hemibarbus longirostris*, Okada 1961). To date, the genus *Acanthogobio* remains a monotypic genus, with *A. guentheri* as its type species.

Based on mitochondrial Cytochrome-*b* (Cyt *b*) sequences, Yang et al. (2006) constructed a phylogenetic tree for the subfamily Gobioninae and found that the genus *Gobio* was not monophyletic; the genus *Acanthogobio* was nested within the phylogenetic tree of the genus *Gobio*. Tang et al. (2011) further explored the phylogeny of Gobioninae using a broader dataset that included Cytochrome-*b* (Cyt *b*), Cytochrome c Oxidase I (COI), Exon 3 of the recombination activating gene 1 (RAG 1), and Opsin (rhodopsin, Rh) sequences. It also showed that *A. guentheri* was nested within *Gobio*. In order to keep the monophyly of *Gobio*, they synonymized *Acanthogobio* as *Gobio* and recognized the species *A. guentheri* as *G. guentheri*.

The phylogenetic tree in this study shows that the *Acanthogobio guentheri* is nested within the genus *Gobio*, sistering to *G. rivuloides* (Fig. 10). The genetic distances between *A. guentheri* and *G. rivuloides* are even closer to the distance between *G. rivuloides* and *G. huanghensis* (0.0415 vs. 0.0890, Table 5). Our results support the conclusion that the genus *Acanthogobio* is a synonym of *Gobio*.

Gobio guentheri is a distinctive species within the genus *Gobio*. Its dorsal fin has a robust, stiff spine, the pre-dorsal region lacks scales, and the ventral scaleless region extends to the posterior pelvic fin. These characters, regarded as the secondary traits, might represent subsequent adaptations to the special habitat in the upper reaches.

Table 5. Genetic distances of the Cyt *b* gene computed by MEGA 11 amongst 5 analyzed species of *Gobio*, *Hemibarbus labeo* was used as the outgroup.

	Species	Intraspecific	1	2	3	4	5
1	*Gobio huanghensis*	0.0015					
2	*Gobio coriparoides*	0.0055	0.0996				
3	*Gobio guentheri*	0.0029	0.0946	0.0833			
4	*Gobio rivuloides*	0.0062	0.0890	0.0888	0.0415		
5	*Gobio meridionalis*	0.0013	0.0901	0.0912	0.0431	0.0068	
6	*Hemibarbus labeo* (Outgroup)	NA	0.1946	0.2173	0.1987	0.1940	0.1946

The distribution of the genus *Gobio* species in the Yellow River drainage

The Yellow River marks the southernmost distribution of the *Gobio* species. A total of ten species belong to the genus *Gobio* in East Asia (Chen 1998; Xie 2007), with four of them inhabiting the Yellow River drainage. Among these four species, *G. huanghensis*, *G. coriparoides*, and *G. guentheri* are endemic to the Yellow River drainage (Li 2015) and only distributed in the upper and middle reaches. This endemism is attributed to the relatively isolated environment of the upper and middle reaches of the Yellow River, formed by the uplift of the Tibetan Plateau (Lin et al. 2024). In contrast, other river systems in northern East Asia were more interconnected during the regression of the Bohai Sea, Yellow Sea, and East China Sea at the Last Glacial Maximum (Yoo et al. 2016), leading to a lack of endemic *Gobio* species in those regions (Xie 2007). Furthermore, *Gobio huanghensis* and *G. guentheri* inhabit only the mainstream, while *G. coriparoides* is primarily found in tributaries. *Gobio rivuloides* can be found in both mainstreams and tributaries.

Gobio species are found exclusively in the upper and middle reaches of the Yellow River basin. However, according to Li (2015), there is no distribution in the section of the Yellow River upstream of Longyang Gorge, nor do they inhabit the lower reaches of the river. They inhabit environments with an average elevation of above 300 meters. *Gobio guentheri* is distributed in the uppermost part of the Yellow River and can be found in Qushian Township, Qinghai Province, on the Qinghai-Tibet Plateau. The lowermost extent of *G. guentheri* distribution is Liulin County, Shanxi Province, but it is rare in this region, with only one specimen collected (Fig. 4D). *Gobio guentheri* is primarily distributed in high-altitude regions, with an average elevation of 630–2,700 meters. *Gobio huanghensis* is widely distributed in both the upper and middle reaches of the Yellow River mainstream (Fig. 4A). The uppermost part of its distribution is in Lanzhou City, Gansu Province, while the lowermost extent is in Yongji City, Shanxi Province. The average elevation of its distribution is 340–1,600 meters. The uppermost distribution of *G. rivuloides* in the mainstream is in Qingtongxia City, Ningxia Hui Autonomous Region, while the lowermost extent is in Sanmenxia City, Henan Province. It also inhabits tributaries such as the Hongnongjian River, the Qijiahe River, and the Luohe River (Fig. 4B). The average elevation of its distribution is 300–1,100 meters. *Gobio coriparoides* is only restricted to the tributaries; it can only be found in tributary habitats in the middle reaches of the Yellow River drainage (Fig. 4C). The average elevation of its distribution is 630–1,260 meters.

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